

**Before the
Federal Communications Commission
Washington, D.C. 20554**

In the Matter of

Expanding the Economic and Innovation)	GN Docket No. 12-268
Opportunities of Spectrum Through)	
Incentive Auctions)	

Comments of Shared Spectrum Company

January 25, 2013

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COMMENTS OF SHARED SPECTRUM COMPANY

I. INTRODUCTION:

Shared Spectrum Company (SSC) is a leader in developing spectrum sharing technologies including Dynamic Spectrum Access (DSA) radios, frequency sensors, and software applications. Founded in 2000, SSC is a small, entrepreneurial business that has been inventing and implementing a broad range of innovative capabilities that enable wireless devices to access or share multiple frequency bands for all types of applications.

For example, the company developed DSA over the past 12 years on several military projects, building prototype devices, and developing software. SSC performed successful DSA radio tests at Fort A.P. Hill, Virginia, demonstrating core spectrum access principals of the Defense Advanced Research Projects Agency (DARPA) NeXt Generation (XG) Communications program.¹

In addition, SSC has been a leading voice in favor of spectrum sharing at the Federal Communications Commission (FCC), with the National Telecommunications and Information Administration (NTIA), and before decision-makers in Congress and within the Administration. For example, SSC filed extensive Comments and Reply Comments in the FCC's Notice of Inquiry concerning use of DSA technology.² There, SSC urged the Commission to: (1) develop a policy-based regulatory framework for spectrum sharing across multiple spectrum bands; and (2) propose spectrum sharing rules for Federal spectrum bands that take into account incumbent requirements and incentives.³

Our history of involvement in the TV White Spaces (TVWS) rule making provides us with a particularly relevant barometer for suggesting how the Commission should proceed with broadcast spectrum re-purposing. In fact, SSC first proposed TVWS sharing to the Commission and has been involved in most major aspects of that, and similar, sharing efforts over the past decade.⁴ Similarly, before NTIA, SSC has been active in leading the charge for more efficient use of our national spectrum resources through sharing.⁵

¹ See, M. McHenry, E. Livsics, T. Nguyen, N. Majumdar, "XG Dynamic Spectrum Access Field Test Results," IEEE Communications Magazine, Vol. 45, no. 6, pp. 51-57 (June 2007), available at http://www.sharedspectrum.com/wp-content/uploads/2007-02_SSC_Description_Demonstrations_Ft_AP_Hill.pdf.

² Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies, *Notice of Inquiry*, ET Docket No. 10-237, 25 FCC Rcd 13711 (Nov. 30, 2010) ("*DSA NOI*").

³ Please see, Comments, Shared Spectrum Company, ET Docket No. 10-237, February 28, 2011, at 20-21.

⁴ For example, please see Shared Spectrum's previous filings with the Commission in Unlicensed Operation in the TV Broadcast Bands (ET Docket No. 04-186); Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies Authorization and Use of Software Defined Radios (ET Docket No. 03-108); Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands (ET Docket No. 03-237); Additional Spectrum for Unlicensed Devices Below 900 MHz and in the 3 GHz Band (ET Docket No. 02-380), and Spectrum Policy Task Force Report (ET Docket No. 02-135), Software Defined Radios (ET Docket No. 00-47) -- which are incorporated herein by reference.

⁵ See, Shared Spectrum Comments filed in response to NTIA's Test Bed Proposal, In the Matter of Spectrum Sharing Innovation Test-Bed Pilot Program, NTIA Docket No. 120322212-2212-01.

In addition, SSC was highly engaged in the development of the July 20, 2012 Report by the President's Council of Advisors on Science and Technology on Spectrum Technology (the PCAST Report).⁶ The PCAST Report specifically concluded that, "The norm for spectrum use should be sharing, not exclusivity," noting that a new spectrum architecture and a corresponding shift in practices could greatly multiply the effective capacity of spectrum.⁷

It is against this background of development of spectrum sharing technology and promotion of policies for deployment of such leading-edge technology, that SSC welcomes the opportunity to comment on the Commission's proposed rule making in this Incentive Auction proceeding.

II. SHARED SPECTRUM COMPANY'S TECHNOLOGY:

As noted above, SSC is the pioneer in developing DSA radio technology.⁸ In addition, our Spectrum Sensing Toolbox (SST) is a commercial product that enables spectrum sharing through highly precise radio frequency sensing by wireless devices of all types that are operating in the TVWS and other spectrum bands. Attached as Exhibit A is an overview of the SST software solution.

We believe that sensing based technologies like the SST can play an important role in the full utilization of TVWS spectrum. As noted in more detail below, sensing can provide real time updates to TVWS databases with both macro and micro benefits.

Among its many features, the SST accurately detects wireless microphones, TV transmitters, LTE signals and other emitters while allowing devices to avoid false alarms, access more spectrum and improve quality of service. The SST is based on over a decade of research and field testing in harsh RF environments for defense, government and commercial users.

In its *DSA NOI*, the FCC examined the development of spectrum sensing, recognizing it as an "important component of dynamic spectrum use" and asked a series of questions on spectrum sensing techniques and issues, including ways to determine the appropriate detection threshold, avoid so-called "hidden nodes" or detect changes to the noise floor.⁹ As mentioned in our Comments and Reply Comments in that proceeding, a key component of SSC's DSA system involves spectrum sensing through several types of

⁶ *Realizing the Full Potential of Government-Held Spectrum to Spur Economic Growth*, Report of the President's Council of Advisors on Science and Technology, July 20, 2012, <http://www.whitehouse.gov/administration/eop/ostp/pcast/docsreports>.

⁷ *Id.*, at vi.

⁸ See, e.g., M.A. McHenry, "System and Method for Reuse of Communication Spectrum for Fixed and Mobile Applications with Efficient Method to Mitigate Interference," U.S. Pat. 7,146,176 (Dec. 5, 2006); M.A. McHenry and A. Leu, "Method and System for Determining Spectrum Availability within a Network," U.S. Pat. 7,564,816 (July 21, 2009); M.A. McHenry et. al, "Methods for Using a Detector to Monitor and Detect Channel Occupancy," U.S. Pat. App. 11/582,496 (Oct. 18, 2006); E. Livsics et. al, "Methods for Detecting and Classifying Signals Transmitted Over a Radio Frequency Spectrum," U.S. Pat. App. 11/839,503 (Aug. 15, 2007); F. Perich et. al, "Method and Device for Policy-Based Control of Radio," U.S. Pat. App. 11/783,563 (April 10, 2007).

⁹ *DSA NOI* at ¶¶ 20-24.

detectors such as SST. SSC also pointed out that it has been a pioneer in developing cooperative sensing (or “group behavior”) solutions.¹⁰

Sensing can also be used on a macro level, such as the 3.5 GHz band or the TVWS band. Sensors can communicate with a database to limit or reduce exclusion zones. Thus, sensing enhances database awareness of open channels; this knowledge, in turn, could lead to permission for higher power devices to operate than those that are currently permitted under the TVWS rules for Mode II TVBDs and fixed devices.

In sum, sensing capabilities such as our SST solution resolve interference on the micro level and enhance real time updates to databases for more efficient macro level operations.

III. COMMENTS:

A. Sharing Spectrum Should Be a Primary Goal of FCC Spectrum Policy.

At Shared Spectrum Company, sharing spectrum is our core mission. We are pleased to see regulatory policy and technology combining to make this vision a reality.

It is with no small degree of gratitude that we note that our core mission has gained significant traction over the past 12 years since our founding. This momentum in favor of sharing is evident at the FCC and the NTIA, which have proposed re-allocating 500 MHz of spectrum from Federal and non-Federal users.¹¹ The same momentum exists within the Administration, which in its recent PCAST Report advocated freeing up an additional 1,000 MHz immediately.¹²

In order to achieve the much greater level of sharing called for by the Commission, NTIA, and the Administration, significant rule changes must be made in this and similar spectrum allocation proceedings. Each time the Commission proposes to auction or otherwise reallocate spectrum, it should, in our view, adopt rules that promote spectrum sharing as part of *its* core mission.

¹⁰ M. McHenry, K. Steadman, M. Lofquist, “Determination of Detection Thresholds to Allow Safe Operation of Television Band ‘White Space’ Devices”, 3rd IEEE Symposium on New Frontiers in Dynamic Spectrum Access Networks (DYSPAN 2008), pp. 144-155 (Oct. 2008), available at http://www.sharespectrum.com/publications/papers/2008-10_SSC_White_Space_Devices.pdf. This paper was also submitted into the record of the TV White Space proceeding. See SSC Letter to Chairman Kevin J. Martin, *Unlicensed Operation in the TV Broadcast Bands*, ET Docket No. 04-186 (Oct. 23, 2008). Similar analysis performed by SSC was submitted into the record of the TV White Spaces proceeding by Microsoft Corporation. See Letter to Julius P. Knapp from Edmond Thomas, ET Docket No. 04-186 (Oct. 26, 2009).

¹¹ See U.S. Dept. of Commerce, “An Assessment of the Viability of Accommodating Wireless Broadband Systems in the 1675-1710 MHz, 1755-1780 MHz, 3500-3650 MHz, and 4200-4220 MHz, 4380-4400 MHz Bands” (October 2010) (“Fast Track Report”), available at http://www.ntia.doc.gov/reports/2010/FastTrackEvaluation_11152010.pdf; U.S. Dept. of Commerce, “Plan and Timetable to Make Available 500 Megahertz of Spectrum for Wireless Broadband” (October 2010) (“Ten-year Plan”), available at http://www.ntia.doc.gov/reports/2010/TenYearPlan_11152010.pdf.

¹² The PCAST Report concluded that “As a result, the most urgent recommendation in this report is that the President issue a new memorandum that states it is the policy of the U.S. government to share underutilized Federal spectrum to the maximum extent possible that is consistent with the Federal mission, and requires the Secretary of Commerce to immediately identify 1,000 MHz of Federal spectrum in which to implement the new architecture and thereby create the first shared-use spectrum superhighways.” PCAST Report at vii.

B. Sensing-only Operations Should Continue to Be Encouraged.

In this NPRM, SSC suggests that as a general rule of thumb, the Commission should keep open the option for radio sensing-only, in addition to the option for using a database-only approach, to determine available channels.

In the TVWS proceeding, the Commission permitted, but did not require, sensing-only as a path forward.¹³ We hope that the Commission will continue to welcome this approach in the instant proceeding by keeping a sensing-only capability as one option for radio users.

In order to meet the goal of the PCAST Report, significant and at times bold measures must be taken to free up additional spectrum for sharing purposes. SSC believes sensing-only is an efficient means to promote increased sharing on the Administration's advanced timeline.

C. Sensing as a Database Option Would Promote Database Competition.

There are approximately ten authorized database providers in the TVWS bands, including Spectrum Bridge, Microsoft, Google, etc. SSC believes that those providers could distinguish themselves from one another by the quality of service they provide to end users.

Database competition could be increased by the addition of sensing technology, such as our SST software platform. This sensing technology, when combined with the database operator's legacy information, would enhance database access to open channels, -- rather than just adopt the current TVWS system whereby the TVBD radio checks-in with the database every sixty seconds.

Additional precedent exists for this type of optional sensing-database regime. In the 3.65 GHz band, satellite receive-stations' exclusion zone can be reduced if the operator can show that its operations will not interfere with the satellite downlink. Upon such a showing, the FCC allows operators to transmit in that portion of what formerly was an exclusion zone.

Similarly, the user in the Incentive Auction bands should be able to demonstrate via sensing and the database, in combination, that it could operate without interfering with the other pre-existing systems. Such a combination of sensing and database cooperation could greatly reduce exclusion zones.¹⁴

¹³ Please see 47 CFR §15.717.

¹⁴ Please see also, Comments of Qualcomm, Inc., ET Docket No. 10-123, at ii-iv (proposing Authorized Shared Access using a database and dynamic spectrum access controller).

SSC believes the Commission should continue to permit such sensing as an optional feature of the database, to be used to enhance database information where those database operators see fit to use it. The marketplace will decide which database operators to patronize with business, and we suspect that it will be those operators that afford the most accurate information, and hence, the greatest access to available channels.

D. Sensing has Macro Benefits and Micro Benefits to a Database Operator.

The primary benefit of sensing at a macro-level is that sensing enhances the information provided to the database by the FCC's license records. Another valuable aspect of sensing is that policing spectrum use becomes possible for the database operator. If a database operator believes that a radio is somewhere, then that operator can police the environment by sensing to see if in fact that radio is operating in that environment. This is a valuable, and often overlooked, aspect of sensing as an optional feature of database management.

In addition, sensing at a micro-level can enhance the performance of those users with smart radios, rewarding them for their purchase. While a "dumb radio" gets a pessimistic answer from the database that it is operating in or near an exclusion zone, a "smart radio" gets more white space access clearance from the database because it can sense below a certain level. In this manner, the combination of sensing and database technologies could encourage adoption of smarter radios in the TVWS and Incentive Auction bands. Those users who want more channel availability will choose to buy the smarter radio.

This type of efficient cooperation between database and sensors could also enhance the ability of Broadcast Auxiliary Service (BAS) and wireless microphones to continue to exist and operate at the micro-level, without interference. Sensing combined with database information makes operation more reliable for wireless microphones and BAS users,-- it helps them to survive in a shared spectrum environment.

E. Responses to Particular Paragraphs of the Notice of Proposed Rule Making.

SSC offers herein several specific Comments in response to certain questions raised by the Commission in the NPRM.

(1) Paragraph 121.

In Paragraph 121 of its NPRM, the Commission discusses sharing the VHF and UHF band. SSC supports sharing channels in this band using sensing technology.

As Shared Spectrum illustrated in its Comments and Reply Comments in the *DSA NOI*, the Commission needs to continue to establish a framework for efficient use of spectrum in all new band-sharing initiatives.¹⁵

¹⁵ Please see, In the Matter of Promoting More Efficient Use of Spectrum Through Dynamic Spectrum Use Technologies, ET Docket No. 10-237 (2010).

In particular, SSC believes that in this proceeding, the FCC should encourage the use of sensors to validate and update the information in databases. In the TVWS band, fixed and "Mode II" devices are required to monitor and update the channel availability every sixty seconds by checking in with the database; however, no such requirement exists for the TVWS database itself to be updated to reflect real world conditions.

SSC believes that sensors deployed in the field, and indeed sensing capability in the Mode II devices themselves, could be used to help update the database with information about what channels are currently available, and what channels are not available, at any given location and point in time.

The purpose of this proposal for sensing capability tied to the database is not to narrow the number of channels available, but to instead more accurately assign channels to portable and fixed devices. Thus, the likelihood of interference would be greatly reduced if this optional type of information were to be provided on a periodic basis to the database.

In addition, where the database lists certain channels as off-limits, sensing could show whether that channel is being used or not used over a period of time. This information could then be reported to the database operator, such as Spectrum Bridge, for example. A persistent view of a channel that the database shows being unavailable but which sensors show is available could lead to a deeper inquiry by the database operator, and the FCC itself, into the true nature of the operation to be protected: is it intermittent operation which shows up maybe once or twice a week? Or is the operator not reaching a certain area because of terrain or other issues, thus rendering use of that channel locally possible to a TVBD portable or fixed device?

Sensing in the field would help the FCC and database operators to better understand, and police where necessary, the real world environment. SSC supports the continuation of such a sensing option for databases, and SSC would suggest the inclusion into TVBD portable and fixed devices of software similar to its SST capability.

By deploying sensors in the field at given intervals, database operators could more efficiently gather results. The FCC could use these results to update its channel records and permit database operators to authorize additional channel sharing or usage.

(2) Paragraph 126.

SSC supports the FCC's proposal in Paragraph 126 for 600 MHz band licenses in 5 MHz blocks and the creation of a guard band for unlicensed use. The FCC proposes a uniform nationwide downlink band but a non-uniform uplink band.

SSC believes that the uplink band use should be supplemented with sensing to permit uplink bandwidths to change based upon location of licensees. The uncertain extent of licensed uplink versus TV spectrum in any area provides an opportunity for

optional use of sensing technology, such as standalone sensors, SST software, and cognitive radios, in order to gain better clarity.

SSC believes that the Guard Band for unlicensed use should have similar rules for sensing, as discussed below.

(3) Paragraph 157.

Here, the FCC seeks comment on end-user device characteristics such as EIRP and filters. SSC advocates sensing software such as its SST in laptops, handhelds, and other devices etc.

The current weaknesses of TVBD rules are that power limits are too low in Mode I and Mode II devices. SSC notes that software solutions, not hardware limits, should be used to better enable higher power operation of TVBDs without interference with existing protected license operations. In order to meet the sharing needs of the PCAST Report, the Commission needs to stress in this proceeding innovative rules for end-user devices, rules which go beyond the approach it has developed in the TVWS band.

(4) Paragraphs 176 and 177.

In this section, the Commission proposes an unlicensed 600 MHz Guard Band of 6 MHz between wireless and broadcast services. Paragraph 177 also invites comment on advances “perhaps similar to development of cognitive radio...”

SSC supports the concept of creating the 600 MHz guard band for unlicensed use, similar to the TV White Space allocation. Sensing has a role in managing unlicensed devices. Sensing tools and software such as SST add value to the overall RF sharing environment.

The current TV White Space methodology creates database-driven exclusion zones which are too broad in frequency scope and in geographic area. Cognitive radio would bring a valuable level of granularity to sharing spectrum.

(5) Paragraph 185.

The Commission invites comments on any technical rules needed. SSC believes that the FCC should promote the optional use of sensors to be deployed in the field in areas where the new Guard Band and Unlicensed Bands will be deployed. These sensors would gather data on the bands and would report periodically, to the database operators, on the use of spectrum and the availability of spectrum.

SSC believes the Commission should raise the power limit of TVBDs in new bands to a higher level than 100 mW. Allowing real world sensing would permit greater certainty, and with it, greater power output on those smart devices in operation.

The Commission should continue to permit sensing-only as an alternative to a database. Where a database is used, the Commission should permit sensing components such as in-field sensing and SST software in devices to report back information.

(6) Paragraphs 232 and 233.

Here, the FCC discusses the unlicensed band and TVBDs. SSC reiterates its support for sensing solutions as stand-alone sharing technology, and SSC believes that future TVBD power limits could be raised if sensing were deployed both as a stand-alone feature in smart radios and in combination with databases as an optional feature.

(7) Paragraph 236.

In this paragraph, the FCC proposes to create a Guard Band. As noted above, SSC supports this proposal if rules are retained to permit sensing as an alternative to a database-only approach and if database operators have the option to utilize sensing to enhance their own information.

(8) Paragraphs 236-238.

In this section, the FCC invites comments on what changes it should make to current White Spaces rules, including its database approach. SSC reiterates its earlier comments on continuing sensing as a stand-alone operation in the TVWS rules, and promoting higher power limits for TVBDS, and smaller exclusion zones.

In addition, sensing can be useful in the Channel 37 radio-astronomy and wireless microphone bands, which are the subjects paragraphs 237 and 238 of the NPRM. Sensing can be very beneficial to avoid Channel 37 interference, for example.

(9) Paragraph 239.

Here, the Commission seeks to strike a balance among competing interests, including broadcasters' ongoing needs, the desires of TV viewers, and the need to allocate more spectrum through the Incentive Auction process.

As noted throughout the PCAST Report, a major goal of the Administration is to advance sharing technologies.¹⁶ The Commission should do so by determining that sensing technology is useful as an optional feature for all devices.

In addition, a network of sensors deployed in the field could play a vital role in maximizing spectrum sharing, especially in congested areas. Moreover, Shared Spectrum Company's SST software-based approach would permit upgrades to existing radios to make them "smart radios" capable of benefitting more from sensing information and feedback.

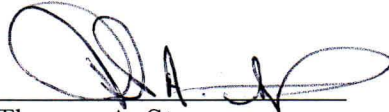
The Commission can strike an effective balance among multiple constituencies involved in this Incentive Auctions proceeding, -- it can "have its cake and eat it too",-- but only if the Commission takes prompt and decisive action: (1) to continue to permit sensing-only networks to be deployed in the field; (2) to promote sensing software such as SST into radios; and (3) to encourage optional database-sensing cooperation.

¹⁶ PCAST Report, at vi and vii.

IV. CONCLUSION:

SSC requests that the Commission incorporate into its new rules provisions encouraging the use of state-of-the-art spectrum sensing technologies consistent with the foregoing discussion.

Respectfully submitted,

A handwritten signature in blue ink, appearing to read 'T. A. Stroup', written over a horizontal line.

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SPECTRUM SENSING TOOLBOX

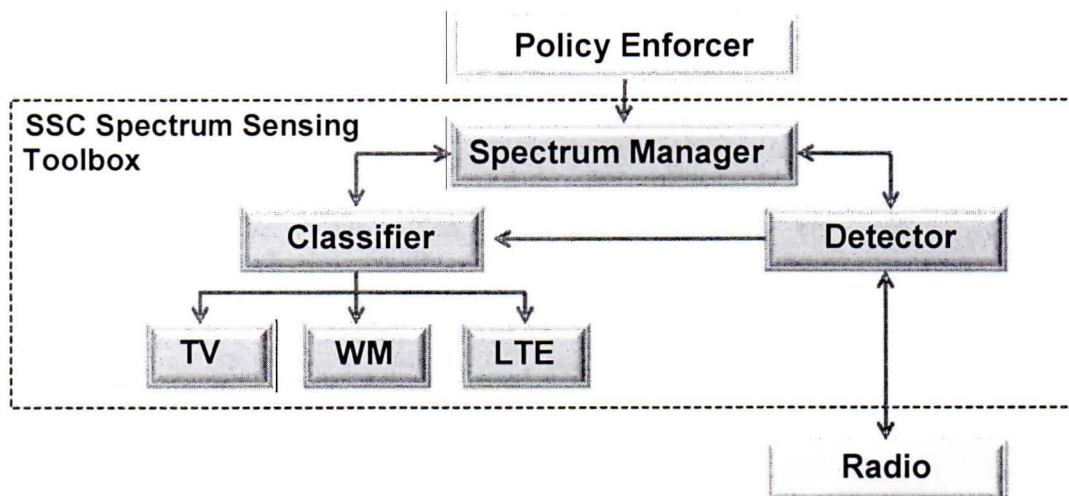
The SSC Spectrum Sensing Toolbox (SST) is an innovative software package that enables highly reliable radio frequency sensing by wireless devices operating in the TV White Spaces (TVWS) and other spectrum bands. The SST helps wireless devices access more spectrum and improve quality of service by accurately detecting TV transmitters, wireless microphones, long term evolution (LTE) devices, and other emitters that may cause interference.

KEY FEATURES

- Performs ATSC, NTSC, wireless microphone, LTE, and wideband signal detection, and classification functions on signals in TV and other bands
- Selects best frequency based on local sensing, database assignments, and user preference
- Low false alarm rate in high ambient man-made noise conditions
- Ranks channels based on user-defined quality of service
- Configurable scheduler targets designated frequencies, processes results, and maintains spectrum information
- Scan rate on the order of milliseconds
- No *a priori* information needed for the LTE classifier
- Over-the-air policy based control and configuration

ADVANTAGES

- Delivers quality of service beyond TVWS databases
- Access more available spectrum
- Rapid software integration via well-defined APIs
- Flexible framework to support additional detectors and classifiers
- Requires a fraction of a cell phone equivalent processor
- Over a decade of engineering and field testing for military and commercial customers
- Inexpensive reference platforms available now



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*May 2012, Sensing Toolbox Version 2.2